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POWER-ASSISTED STEERING SYSTEM OR POWER STEERING SYSTEM

The present invention relates to a power-assisted steering system or power steering system according to the species defined in Claim 1.

In power-assisted steering systems or power steering systems having an electric motor, which drives a worm gear mechanism that includes a composite gear wheel preferably having a plastic ring gear, the composite gear wheel ensures a high degree of running smoothness with high economic efficiency, when the worm gear mechanism has large dimensions and is paired with metallic wheels having a high degree of edge smoothness. Composite gear wheels are well-known.

WO 01/44694 A1 describes a composite gear wheel, which is suitable for a worm gear mechanism of a power-assisted steering system or power steering system, having a two-piece ring gear that is screwed onto a hub. The hub has an annular flange on one axial end. The ring gear is form-locked to the hub by a disk, which is positioned in the axial direction of the composite gear wheel, on the opposite side of the annular flange. Both the disk and the annular flange of the hub have an annular projection, which, in each instance, engages with an annular groove on the side faces of the ring gear in the axial direction of the composite gear wheel and secures the ring gear in the radial direction.

To transmit the torque from the ring gear to the hub or vice versa, threaded bolts are guided through the disk, the ring gear, and the annular flange of the hub. The individual component parts and, in particular, the threaded bolts are not self-centering, which is why the power transmission in the

composite gear wheel and the assembly sequence of the composite gear wheel are not optimized.

The object of the present invention is to improve a composite gear wheel for power-assisted steering systems or power steering systems having an electric motor that drives a worm gear mechanism, so that the assembly of the gear wheel is simplified and the power transmission in the composite gear wheel is uniform.

In the case of power-assisted steering systems or power steering systems having an electric motor that drives a worm gear mechanism, the object is achieved by a composite gear wheel having the features of Claim 1.

Since the annular, axial projection of the disk has a depression in the axial direction and a keyed connection in the tangential direction is rendered possible at an axial side face of the ring gear by a projection and by a depression, a centering aid which allows simple, rapid assembly of the composite gear wheel is provided in the tangential direction between the disk and the ring gear. In particular, when a plurality of depressions are provided, it is possible to achieve uniform torque transmission between the hub, disk, and ring gear, distributed over the circumference of the disk.

Advantageous embodiments are derived from the dependent claims.

The keyed connection between the disk and the ring gear is accomplished by projections and depressions on the disk, and by complementary projections and depressions in the side face of the ring gear in, in each instance, the axial direction of the composite gear wheel. The depressions and projections form a drive-type toothed section in the tangential direction.

It is useful for the projections and depressions to be block-shaped and to be positioned about the circumference of the disks and the ring gear, in that the depressions rectangularly pass through the originally annular, axial projection on the circumference of the disk in a radial direction. The depressions may also pass through the annular, axial projection, having curved edges. The disk may be formed in one piece with the hub or suitably fastened to the hub in a form-locked or force-locked manner. The ring gear is preferably axially fixed between two disks and fastened to the hub by them in a rotatably fixed manner. The shape, cross-sectional shape, and the inner and outer diameters of the second disk are preferably similar to or the same as those of the first disk. The second disk likewise has an annular, axial projection, which is interrupted by one or more depressions and is directed towards an axial side face of the ring gear.

The shape and the number of depressions and projections on the second disk and the side face of the ring gear are preferably the same as on the first disk and on its complementary side face of the ring gear. They are preferably conically interlocking.

The second disk is connected to the ring gear and/or to the first disk fastened to the hub, using rivets or threaded bolts or friction welding.

The design of the composite gear wheel according to the present invention is suitable for making the ring gear out of a thermoplastic or duroplastic synthetic material. The composite gear wheel is preferably capable of producing a low-noise gear unit of a power-steering system or power-assisted steering system of a vehicle, and in particular as a worm wheel of a steer-by-wire system.

The present invention is now described in detail on the basis of an exemplary embodiment and is represented by the enclosed drawing. The figures show:

Fig. 1 a longitudinal cross-section of a composite gear wheel along line II-II in Fig. 2;

Fig. 2 a view of the composite gear wheel in arrow direction I in Fig. 1; and

Fig. 3 an exploded view of a further composite gear wheel.

Shown in the drawing is a composite gear wheel, as is used in a worm gear mechanism for power-assisted steering systems or power-steering systems, where the gear wheel is used as a worm wheel that engages with a worm or worm gear, in order to provide steering assistance or to produce the entire required steering force.

Shown in Figure 1 is a longitudinal cross-section of a composite gear wheel 1 along line II-II in Fig. 2. Composite gear wheel 1 is made up of a cylindrical hub 3, on whose one axial end 14 a first disk 2 having a crimped cross-section is formed in one piece; of an annular ring gear 4; and of a second disk 12. Ring gear 4 is made of a thermoplastic synthetic material. First and second disks 2, 12 terminate ring gear 4 in the axial direction and are pressed against it with the aid of six rivets 15, which pass through disks 2, 12 and ring gear 4. Hub 3 and first and second disks 2, 12 are made of metal.

On their outer circumferential edges, the two disks 2, 12 have an annular projection 5, 5' facing ring gear 4 in the axial direction. Annular projections 5, 5' are interrupted by

depressions 6, 6', which have a rectangular cross-section when viewed in the radial direction of disks 2, 12 (cf. Fig. 3). In the composite state of composite gear wheel 1, tooth-like projections 5, 5' formed in this manner extend into depressions 7, 7' on axial side faces 8, 8' of ring gear 4. In this manner, a keyed connection with ring gear 4 is produced in the radial and tangential directions of disks 2, 12. Depressions 7, 7' and projections 5, 5' are preferably formed comically with respect to each other, which simplifies the assembly of composite gear wheel 1. Depressions 6, 6' on disks 2, 12 are positioned at the same tangential distance 9 from each other and form a drive-type toothed section 10, which points in the axial direction towards ring gear 4, at the outer circumferential edge of disks 2, 12. Instead of in a conically even manner, edges 11 of projections 5, 5' may also run towards depressions 7, 7' in a conically curved manner.

As shown by Fig. 2 in a plan view of assembled gear wheel 1 in arrow direction I in Fig. 1, and as shown by Fig. 3 in an exploded view of a further assembled gear wheel 1, rivets 15 are positioned axially symmetrically with respect to each other in the radial direction in the vicinity of the hub and are mounted flush with the outer contour of disks 2, 12. Ring gear 4 has straight-cut teeth. Inner diameter 16 of ring gear 4 extends into the disk support, which means that elastic, radial and axial expansion of plastic ring gear 4 caused by, for instance, water absorption or the effect of temperature may occur without acting on the connecting points of rivets 15.

In contrast to gear wheel 1 shown in Figures 1 and 2, gear wheel 1 in Figure 3 is made up of a hub 3, two disks 2, 12, and a ring gear 4, which means that hub 3 and disks 2, 12

represented separate component parts to be connected in a form-locked manner.